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Explaining the Exchange Rate Pass-Through in Hungary: Simulations with the NIGEM Model

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Abstract

This paper explores the major determinants of the exchange rate pass-through to CPI. The simulations were performed with the Bank's estimated Hungarian block linked to the NIGEM model of the National Institute of Economic and Social Research (NIESR). The modelling framework offers some insight into the role of different markets in the price-exchange rate relationship. The paper gives an analysis of the relative importance of expectations, goods and labour market parameters. Our results show that the contribution of goods and labour market parameters to explaining the economy-wide exchange rate pass-through changes over time. While goods market adjustment is significant from the start of an exchange rate shock, the labour market starts to gain importance only from year three and onwards. More specifically, the effect of mark-up adjustment prevails over the whole horizon, which indicates that it is the most significant channel in exchange rate pass-through. The slow appearance of labour market effects might be explained by the presence of nominal wage rigidities, which make the adjustment in quantities faster. These results may explain the current labour market behaviour seen after the introduction of the inflation-targeting regime in Hungary. Hence we argue that the exchange rate shock in 2001 is still too close in time to draw conclusions on the role of labour market rigidities in Hungary.

JEL Classification Codes: E17, E30, E37
Keywords: Inflation, Exchange rate, Pass-through, Modelling, Transition economies

Introduction

In May 2001, Magyar Nemzeti Bank (MNB) changed its monetary regime from a crawling band (quasi-fixed) exchange rate to an inflation targeting (IT) framework. In order to disinflate, the Bank has widened the exchange rate fluctuation margins to ±15%. This has led to a sharp appreciation of the currency. As Hungary is a small open economy, the exchange rate is by far the most important channel, influencing consumer prices through changing tradables prices and co-ordinating nominal expectations in product and labour markets. Hence, the Bank has viewed the appreciation as a necessary tool to achieve the inflation targets.

Though inflation more than halved (falling from 11 percent to less than 5 percent), Hungary's one and half year experiences with inflation targeting has highlighted the fact that the disinflationary effect of exchange rate appreciation might be somewhat smaller than originally expected. This is coupled with the puzzling fact that wages have not yet adjusted to the significantly lower inflation environment. Although one can find several other plausible explanations for this puzzle - such as the effects of expansionary fiscal policy and the change in the minimum wage-, in the paper it is argued that even without these shocks, wage adjustment should not necessarily happen in the early years after sharp nominal appreciation.

Both the amplitude and the time-pattern of the pass-through of exchange rate shocks to consumer prices depend on several factors, especially the flexibility of goods and labour markets. These factors also highly influence the real costs (output-loss and slowdown of exports) of exchange rate based disinflation.

In this paper we will attempt to find the major determinants of CPI-exchange rate pass through with regard to both importance and timing. This may give an explanatory framework for the process and determinants of disinflation based on the exchange rate as the major policy device. The simulations have been performed with the Bank's estimated Hungarian model, linked to the NIGEM model of the National Institute of Social and Economic Research (NIESR). Due to the nature of this modeling framework, the parameters are constant over time. As a result, we have not been able to model several important aspects of disinflation, such as credibility gains or institutional changes. Thus, our analyses may not be defendable, in a strict sense, against the Lucas critique. Despite these problems we believe that the simulations will provide useful insights on how the different markets of the economy contribute to the observed behaviour of consumer prices.

The paper is set up as follows. Section one gives a brief outline of the problem that motivated our research. Section two gives a summary on the available theoretical and empirical results on the determinants of the exchange rate pass-through. Section three presents our modelling framework, while section four presents the results. Section five offers some conclusions.

1. The problem

Since 2001, the introduction of inflation targeting in Hungary, the nominal forint exchange rate has strengthened substantially. As noted above, the common view at the Bank is that the strong currency is necessary to achieve the disinflation path required for quick nominal convergence vis-à-vis the EMU. While there is a clear consensus among the Bank's economists that the exchange rate is by far the most important channel in the transmission mechanism, we are relatively less sure about how it exactly works across the different markets in the economy.[1]

In this paper we define pass-through as the elasticity of (non-regulated) prices to nominal exchange rate shocks. It is worth mentioning, however, that this definition is broader than the one used in the Bank's Quarterly Reports on Inflation. The latter refers to the *partial* concept: the *ceteris paribus* change in tradable prices with respect to exchange rate changes. Since the introduction of inflation targeting (IT) the MNB has conducted a few studies to assess the possible role of the exchange rate in the disinflation mechanism. Darvas (2001) estimated the exchange rate pass-through for a concept of market CPI, using a latent concept of the equilibrium exchange rate. As it turned out the Hungarian pass-through was relatively quick, nevertheless the underlying economic structure remained only partly explained in the paper. Benczúr et al (2002) use a small calibrated macromodel to assess the role of the real exchange rate and real interest rate channel in the disinflation process.

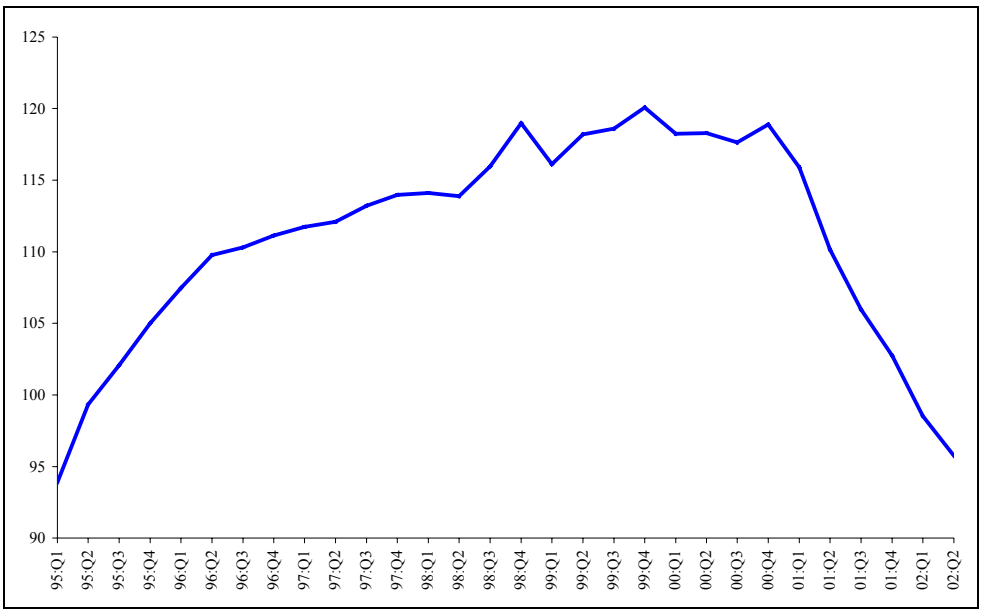
On the other hand, since the introduction of IT, some caveats have emerged regarding the functioning of the Hungarian economy: Firstly, overall exchange rate pass-through turned out to be smaller than originally estimated. Secondly, the labour market reacted substantially differently from what was expected. Private sector wages have not adjusted to the lower level of inflation, and most of the adjustment has taken place in employment (mostly in the manufacturing sector). This phenomenon can be summarised in the unit labour cost based real exchange rate (see Figure 1), which has appreciated sharply and this trend has not ended so far.

As we shall see later, the smaller than expected (overall) exchange rate pass-through may be explained by the regime change. This result conforms to international evidence.[2] The reason for the absence of nominal adjustment in the labour market is less clear cut. As the institutional structure of the Hungarian labour market should be relatively flexible due to decentralised wage bargaining, at first sight it is hard to explain why companies react more with quantities than with prices in their labour-demand.

[1] It is important to note, however, that credible inflation targeting in itself means that the importance of the exchange rate channel decreases over time, as the Bank commits itself to not allowing currency fluctuations to pass through to an already stable inflation level. This also means that relying on the exchange rate argument for too long might cause credibility problems. See a detailed discussion later.

[2] See Campa and Goldberg (2002) for broad international review and Darvas (2001) for evidence on transition countries.

Figure 1: Unit labour cost based real exchange rate in manufacturing*
(1995=100)



** An increase indicates depreciation*

By decomposing the exchange rate pass-through, the main contribution of the paper is underlining the importance and timing of different markets in disinflation. It is found that the quickest disinflationary effect comes from the permanent decrease in import prices. However, the adjustment process does not end here. The narrowing of the output gap (mark-up effect) helps in further disinflation. Lastly, labour market adjustment becomes a significant determinant in the exchange rate pass-through from year three and onwards. This might happen as wage adjustment can be achieved via an increasing unemployment rate after the slowdown in GDP due to the real exchange rate channel. This result also explains why companies reduce employment first and adjust wages only later.

2. Literature survey

Studying the exchange rate pass-through is a very controversial task for researchers. On the one hand, there is a vast amount of theoretical and empirical research on the topic involving one in a very complex field of international economics.[3] On the other hand, there is much less literature applicable to the analysis of transition or accession countries.[4] The huge amount of literature makes it possible to gain some, more or less consensus, insight on the exchange rate pass-through.

In the analysis of pass-through the first natural question is the definition of the concept. The term pass-through is usually defined as the effect of a one percent

[3] Excellent surveys can be found in Goldberg and Knetter (1997), Engel (2002), Campa and Goldberg (2002) and Obstfeld (2002), just to mention a few.
[4] See Darvas (2001), Világi (2002).

exchange rate change on prices. However, the price category used in the definition is far from being obvious. Import prices[5] are chosen at least a frequently as CPI.[6]

Import prices are natural candidates for estimating the effect of the exchange rate on prices, as they are prices of traded goods by definition. Due to this, we expect them to converge to Purchasing Power Parity (PPP) at a much quicker pace than broader price categories. On the other hand, import prices are important determinants of the CPI, so understanding the pricing behaviour of the former makes an important contribution to understanding the latter.

Nevertheless, from a monetary policy point of view, it is worth looking at the whole process of how the exchange rate feeds into CPI prices. Given the mixed focus in the literature, we rely on both definitions when surveying the papers, but later in our simulations we focus on the pass-through to CPI, due to the interest of our paper.,.

As the pricing policies of firms are based on maximising expected profits, every variable that affects the size or the variance of expected profits has some influence on the pass-through.

2.2. Pass-through determinants

Besides the direct cost effects (through import prices) of nominal exchange rate changes, traditional open economy macroeconomic models also put emphasis on the expenditure-switching effect of nominal exchange rate changes. An appreciation of the nominal exchange rate leads to lower exports and a substitution of domestically produced goods with imported goods. At the same time, it also changes the terms of trade and import prices. Through its effect on the real economy, relative price change enforces price adjustment and new equilibrium is reached as a flexible price solution, i.e. in the long run the real exchange rate is driven by fundamentals.

However, this traditional view on the transmission of exchange rate shocks into real economy and price adjustments invites some criticism. Devereux and Engel (2002) claim that consumer prices are generally found to be very unresponsive to nominal exchange rate shocks. This implies that the "expenditure-switching" channel might be small for developed countries with low inflation rates. If the exchange rate change has little effect on the behaviour of final purchasers of goods, then it may take large changes in exchange rates to achieve equilibrium after a shock to fundamentals. Hence, small expenditure switching also implies large volatility in nominal exchange rates.

The new literature (usually referred to as "new open economy macroeconomics") attempts to give a firmer micro foundation for our understanding of how the nominal exchange rate can help to reallocate resources.[7] In the analysis of the pricing decisions of firms, retailers and consumers' demand gives a deeper and more complex understanding of the effect of nominal exchange rate shocks on prices.

[5] See Froot and Klemperer (1989) Ohno (1989), Goldberg and Knetter (1997), Campa and Goldberg (2002) among others.
[6] See Fisher (1987), Klein (1990), Murgasova (1996), Choudri et al. (2000), Taylor (2000) among others.
[7] For more on new open economy macroeconomics, see e.g. Obstfeld (2002), Obstfeld – Rogoff (1999), Obstfeld – Rogoff (2000) and Devereux and Engel (2000).

Devereux et al (2002) present a model where, depending on the macroeconomic structure, producer or local currency pricing is changed endogenously by the firm. Ceteris paribus, the higher is the volatility of the *exchange rate* and the more foreign companies use producer currency pricing (PCP), the higher the exchange rate pass-through becomes. On the contrary higher exchange rate volatility may mean noisier exchange rates, which from a signal extraction point of view, may decrease the pass-through.

Several theoretical papers have dealt with the effect of monetary policy stability on the exchange rate pass-through.[8] The general conclusion is very similar to that of the exchange rate volatility, that is the more unstable monetary policy becomes in a country, the more foreign exporters will use PCP, entailing higher exchange rate pass-through. Taylor (2000) goes further by hypothesising that there was a strong connection between two observations, the decline in the average *inflation rate* in developed economies and the decline in the pass-through coefficients during the late nineties. Taylor argues that the decline in inflation is associated with a declining persistence of inflation. Smaller persistence means higher credibility of the central bank with regard to inflation remaining in a stable interval. This also means that higher credibility leads to lower pass-through, that is a less effective exchange rate channel.

Taylor's proposition has important implications for monetary policy makers in small open economies fighting against inflation. If the rate of inflation and the exchange rate pass-through are positively correlated, then the more successful the disinflationary policy is the less effectively the exchange rate can be used as a transmission channel in these countries. This result may seem paradoxical at the first sight, although it becomes easily understandable in the light of the concept of credibility. Credibility is the private sector's belief that the central bank will not allow exchange rate fluctuations to feed into inflation and move it away from the target. By believing in this, they do not allow the weaker exchange rate to affect their sales prices at the risk of increasing their prices individually and losing market share.

Country size may also matter. As Dornbusch (1987) points out, since larger countries have relatively fewer foreign competitors, they can price with smaller exchange rate pass-through.

Historically, microeconomic determinants were also among the first explanations in imperfect exchange rate pass-through. Since the seminal paper by Krugman (1987) *demand elasticities* and *industry structure* have appeared as one of the major explanations for the persistent deviations from the law of one price.[9] These considerations show that the pass-through coefficient is a decreasing function of both *demand and foreign exporters marginal cost elasticity*. It is easy to see intuitively that the more strongly demand responds to price changes, the less likely producers are to change prices due to exchange rate fluctuations. At the same time, a higher marginal cost elasticity of foreign production means that costs and revenues move in the opposite direction due to exchange rate fluctuations, which gives companies a natural hedge position.

Summing up the literature, Engel (2002) disentangles six main factors affecting exchange rate pass-through in new open economy macro models. Firstly, flexible and

[8] Klein (1990), Deveroux et. al. (2002)
[9] See also Goldberg and Knetter (1997).

sticky price models behave differently. Secondly, the case of local currency (LCP) and producer currency pricing gives totally different pass-through. Thirdly, labour market conditions (sticky or flexible wages) are key in price dynamics, as well. Fourthly, shipping costs can alter the behaviour of final goods' prices. Fifth, the vast majority of traded goods can be viewed as a bundle of goods and services. Hence, non-traded (distribution and retail-related cost) content in traded goods' prices very heavily influences the transmission of nominal exchange rate shocks. Sixth, in the case of LCP, markets can be segmented and give floor to local price discrimination and monopolistic pricing, leading to large swings in mark-ups due to nominal exchange rate shocks.

What can be said about the relative importance of the different determinants? Unfortunately, according to our knowledge, there are not too many studies trying to assess systematically the quantitative importance of the different determinants. The only exception is Campa and Goldberg (2002), who estimate the import pass-through on a large panel of OECD countries. According to their results, most of the observed decline in the pass-through might be explained by the changing composition of trade, rather than macroeconomic variables. In fact, the only significant macroeconomic variable is the inflation rate, nevertheless its explanatory power is still negligible.

By contrast, on the basis of less comprehensive regressions between the CPI exchange rate pass-through and macro variables, Choudri and Hakura (2001), Gagnon and Ihrig (2002) and Hampton (2001) provide evidence in support of Taylor's proposition. These authors found monetary policy or the level of inflation to be significant determinants of the CPI pass-through.

3. The modelling framework

For summing up the different aspects of the exchange rate pass-through it is worth turning it into a macromodel that can handle the various aspects of the problem simultaneously. By using a macromodel, we leave out the opportunity to explain microeconomic determinants (elasticity of demand, trade composition) in a deeply structured manner, although as we will see, most of the parameters in the macro-equations can also be associated with some microeconomic concepts. As we wanted to give a more or less comprehensive picture on the determinants, we also endogenized the labour market in the analyses.[10]

For our illustrative exercise, we have modified the Hungarian block of the NIGEM model to be able to tackle explicit forward-looking expectations in both the price and wage formation. As the very detailed description of the NIGEM model can be found in Jakab – Kovács (2002), here we only focus on its main features.

The NIGEM is basically a standard estimated model with New-Keynesian theoretical background where agents are assumed to be forward-looking at least on some markets, but nominal rigidities slow down the process of adjustment to various shocks. The economy is a one-sector model with a detailed demand and supply side, and a consistent stock-flow relationship.

[10] According to our best knowledge, there are very few studies endogenizing the labour market in studying the exchange rate pass-through. One exception is Hughes-Hallet et al. (1995).

As we have been able to see it already, the effect of exchange rate shocks on prices crucially depends on how prices and costs adjust to it. Thus the wage-price block plays a dominant role in the adjustment process.[11] The wage-price block in our model contains the following basic equations (all equations are in logs):

$$pma = rx + pxa^* \tag{1}$$

$$\Delta p = -\gamma_p (p_{-1} - \alpha ult_{-1} - (1-\alpha) pma_{-1}) + \theta_p cu + \delta E(\Delta p_{+1}) \tag{2}$$

$$\Delta w = -\gamma_w (w_{-1} - \phi pr_{-1} + \theta_w u_{-1}) + E(\lambda_1 \Delta p_{+1}) + \lambda_2 \Delta p + (1 - \lambda_1 - \lambda_2)\Delta p_{-1} \tag{3}$$

where

- *cu* is the output gap
- *p* refers to the consumer price index
- *pma* denotes import price
- *pxa** is the effective export price of foreign competitors in US-dollars
- *pr* is labour productivity
- *rx* is the HUF/USD exchange rate.

(1)-(3) refers to quite a standard wage-price block. Firstly, we assume that the exchange rate pass-through to import prices is immediate, so we assume PCP. The validity of this choice was reinforced by our simple statistical description of the data.[12]

Secondly, producers adjust the general price level – which in this case equals the consumer price, in the long run to total unit cost, while the mark-up over costs is adjusted according to cyclical fluctuations, and measured by the output gap (θ_P).[13] Prices are also partially forward-looking, the δ parameter measures the extent future expected prices are discounted. (future price discount).

Thirdly, the wage equation refers to a wage bargaining process à la Layard et al. (1991). Real wages are determined by productivity and the unemployment rate in the long run (wage fundamentals). In the short run, however, expectations also play a key role. As regards the coefficient on productivity we call this effect real wage flexibility, while we refer to the unemployment elasticity as nominal wage flexibility, the slope of the wage-curve.[14]

[11] In fact the exchange rate pass-through depends on *all* of the parameters in the model, so though quite ample, a similar decomposition can be done with respect to all of the parameters in the model. However, naturally the pass-trough is the most sensitive with respect to the wage-price block parameters.

[12] We ran regression on import unit values and exchange rates and found that only the contemporaneous exchange rate had significant explanatory power on import prices.

[13] The mark-up is generally viewed as a sign of monopolistic competition, and it is closely linked to the price elasticity of demand. As firms adjust their prices to demand shocks, mark-up fluctuations are pro-cyclical and can be proxied by capacity utilisation.

[14] See also Hughes Hallett et. al. (1995).

From equations (1)-(3) and the discussion above it is obvious, that the price-wage block are determined by the following terms:

(1) cost share: α
(2) unit cost adjustment: γ_p
(3) mark-up elasticity: θ_p
(4) future price discount: δ
(5) real wage rigidity: φ
(6) nominal wage rigidity: θ_w
(7) wage adjustment:γ_w
(8) price expectations in wage bargaining: λ_1, λ_2

3.4. Simulation parameters

As a baseline parameterisation of the economy, we use the current NIGEM parameters of the Hungarian block further developed from the one employed by Jakab-Kovács (2002). This basic parameterisation gives values for the long run fundamentals and adjustments to them and for the mark-up elasticity. It is worth mentioning that the baseline NIGEM pass-through coefficient is somewhat higher (around 25 percent in four quarters) than the one used in the inflation projection model at the MNB (around 15 percent in one year). The main reason for this difference lies in the treatment of regulated and food prices in the MNB's inflation projections. These items are taken as exogenous factors, which are not very responsive to exchange rate shocks in the short run. Hence our NIGEM simulation results should be regarded as pass-through to *market-priced components* in the CPI.

We cannot obtain a parameter from the basic NIGEM setup for the expectations variables. As a baseline scenario, future price discount in the price equation takes the value of 0.2, which is similar to the basic assumptions of Benczúr et al (2002). For the sake of simplicity, we assumed that the coefficients on the forward-looking element in wage bargaining (λ_1) equals to the future price discount, and λ_2 equals to 0.4.

Table 1 summarises our baseline parameters. Comparing them with the corresponding NIGEM values for developed OECD countries, there are significant differences.

Firstly, the domestic cost component is higher in the OECD average compared to Hungary. Secondly, the effect of productivity in the long run is constrained to be unity in developed OECD countries, while this restriction was not supported by the data in Hungary. Thirdly, the mark-up and nominal wage flexibility parameters are higher in Hungary, which can be partly explained by a higher level of inflation. Fourthly, unit cost adjustment at first sight seems to be higher in developed economies, although in the developed country models there are two-stage price systems, which do not allow for perfect comparability with the Hungarian parameters.[15] Fifthly, the extent of forward-looking behaviour in wage formation is higher in developed countries, while in the price equation expectation terms are usually not applied.

[15] In most cases γ_p refers to the adjustment of wholesale prices in developed countries, which ceteris paribus adjust more rapidly to costs than consumer prices.

Table 1: Baseline parameters and average NIGEM values

Scenario/parameter	α	φ	θ_p	θ_w	γ_p	γ_w	δ	λ_1	λ_2
Hungarian baseline	0.31	0.75	0.17	0.08	0.07	0.16	0.20	0.2	0.40
Average NIGEM values	0.44	1.00	0.08	0.02	0.18*	0.12	0.00	0.34	0.54

** Not the same concept as in the Hungarian model, see also footnote 15.*

As mentioned already, in the paper we were interested in explaining the structure of the pass-through with respect to different wage-price block parameters. However, as the model contains a system of non-linear simultaneous equations, it is practically impossible to determine how the pass-through exactly depends on the different parameters of the model as everything is interrelated. Taking into account this problem, what we did was an approximate decomposition of the model in the small neighbourhood of the baseline parameterisation. With this methodology we have been able to present how the model behaves with respect to small ceteris paribus changes in certain parameters.

Our experiment on the importance of pass-through determinants was set-up as follows: (1) First, we simulated the model with its baseline parameters providing an exchange rate shock specified below. (2) Then we simulated the model for different scenarios, increasing the coefficients one by one by ten percent, while at the same time the remaining coefficients were fixed at their baseline scenario values.[16] (3) Finally, we looked at the difference in the pass-through of the individual runs and the baseline case, and compared the differences with the sum of the individual changes. If our "implicit" linearisation is valid, then the sum of individual parameter changes must approximately amount to a simultaneous change in all of the parameters in the wage price block.

For the purpose of our experiment, we refrained from changing the cost share parameter (α), as this is a deep technological aspect of the economy, therefore it is not too interesting in our analyses. While assessing the importance of price fundamentals, we simply assumed that unit cost adjustment might change but the cost shares remained fixed.

By contrast, in the wage equations we were interested in both real and nominal wage rigidities. But as we analysed both parameters, we left the wage adjustment term at its baseline values in all the scenarios, as percentage change in the wage adjustment may be achieved with a simultaneous increase in both nominal and real wage rigidity parameters.

For the analyses of the effects of expectations, we changed the expectation parameters in price and wage equations simultaneously, as different expectations in price and wage formations are difficult to interpret.

- In the “expectations scenario” the forward-looking coefficients were increased both in the price and wage equations. As the sum of the expectation terms equals one in the

[16] An alternative decomposition could have been used to assess model sensitivity with respect to changes in the standard error of their parameters. However, we remained at our methodology mentioned above, owing to two main reasons. First, we were interested in structural type decomposition, and not forecasting uncertainty. Second, for several parameters, the standard errors were obtained from various samples, which made the comparability of the error bounds dubious. As a result, we did not have any information on the covariance of errors in the equations, either.

wage block, the increase in the forward-looking part meant an equal decrease in the backward-looking part of the equation.

- In the "unit cost adjustment scenario", the adjustment coefficient to unit cost was raised.

- In the "mark-up scenario", the coefficient on the output gap variable was increased.

- The "nominal wage flexibility scenario" means that the unemployment rate coefficient was reinforced.

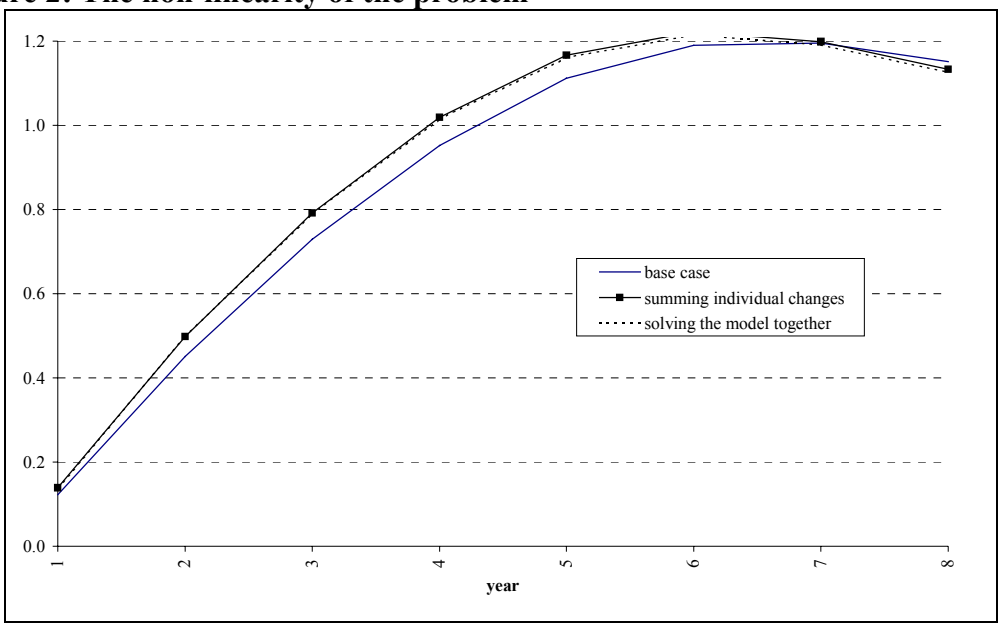
- In "real wage flexibility" the adjustment coefficient of productivity was raised.

The data set for the simulations was taken from the NIGEM database.

4. Results

In general, equilibrium pass-through coefficients depend on all of the parameters in the model. As already mentioned, from among all of the possible parameters only the wage price block coefficients were considered. For assessing the importance of the different parameters, a permanent eight and a half percent appreciation shock to the exchange rate was given to the model in all cases.[17] In the interest of the comprehensiveness of our analyses, we also ran a simulation, where all of the parameters of interest were increased at the same time. If the problem is basically linear, then individual changes should equal to a simulation with changing all of the parameters simultaneously. Figure 2 proves that our linear approximation worked well, the difference between the sum of individual changes and simultaneous increase in all the parameters of the wage price block is very small.

Figure 2: The non-linearity of the problem



[17] This is the corresponding nominal appreciation experienced in Hungary since the introduction of the inflation targeting (IT) regime in May 2001.

The results of our methodology can be found in Table 2, where the percentage contribution of different parameters to changes in the pass-through coefficient is presented.

Table 2: The contribution of the determinants of exchange rate pass-through to CPI (%)

Year	Expectations	Unit cost adjustment	Mark-up adjustment	Nominal wage flexibility	Real wage adjustment
1	28.8	50.4	20.5	0.0	0.3
2	21.7	39.9	35.8	1.1	1.4
3	19.4	32.7	39.1	5.4	3.5
4	17.1	24.8	40.8	11.9	5.5
5	15.3	14.7	45.1	17.3	7.7
6	13.5	-3.2	56.5	20.4	12.8

It can be observed that in the first three years, there are three major determinants of the pass-through: expectations, adjustment to unit costs and mark-up adjustment. This is not surprising as all of these parameters enter in the price equations, so they are directly linked to our question. In the first year, unit cost adjustment and expectations play a major role. At the start of the exchange rate shock, import prices adjust relatively quickly making the unit cost adjustment fast – a permanent change in the exchange rate has a one-for-all effect on import prices and on CPI. In the second, and especially the third year mark-up adjustment gains importance, and its contribution prevails over the whole horizon. Following the import price effect, real appreciation and higher real wage decrease income, and lead to lower than potential output.

And finally, for the effect that comes from the labour market. In the first 2-3 years labour market parameters do not really affect the pass-through, in the fourth years nominal wage rigidity becomes an important determinant, while real wage adjustment remains below 10% on the whole horizon. Table 3 gives further insights into the problem. Combining the effects of goods and labour market parameters, we find that labour market matters in an exchange-based disinflation only from year three and onwards, while the importance of adjustment in the goods market appears immediately and persistently.

Table 3: The importance of expectations, goods and the labour market in the pass-through (%)

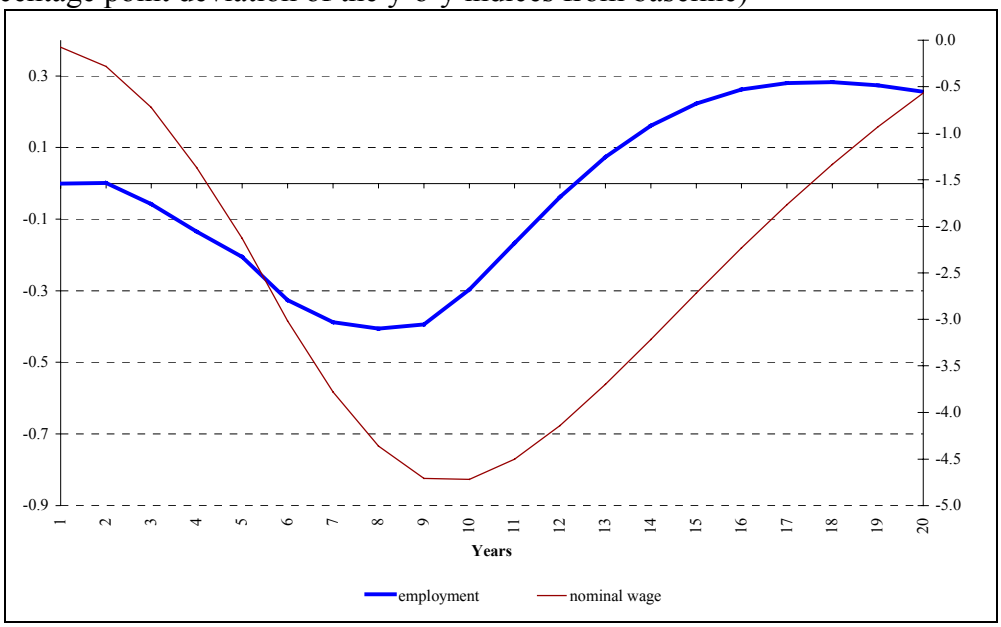
Year	Expectations	Goods market	Labour market
1	28.8	70.9	0.3
2	21.7	75.7	2.5
3	19.4	71.8	8.9
4	17.1	65.5	17.3
5	15.3	59.8	24.9
6	13.5	53.3	33.3

Our results may provide an explanation of the phenomenon that while inflation has moderated substantially, and slowdown in growth has also been discernible after a steady nominal appreciation of the forint, labour market adjustment has not taken place so far. Our results reveal that labour market adjustment should lag behind import price and output gap adjustments, and it does seem to matter rather in the

medium than in the short term. The fact that the pass-through is not affected by labour market conditions in the first few years suggests that clear statements on the rigidity of labour market adjustment cannot be made on the basis of the observations concerning the first few years. A flexible and a more rigid labour market has markedly different consequences only after the third year.

Why is the labour market response so slow in explaining price behaviour? Firstly, it takes additional time for the labour market conditions to feed into pricing behaviour. This is because labour market feeds into prices only indirectly, while the exchange rate affects them also directly. Secondly, it takes time while wages start to react significantly to slackening labour market conditions. In Figure 3 the response of employment and the nominal wage rate is presented on the basis our baseline parameters. It can be observed that there is more than a half-year lag between the through of employment and wage adjustment fuelled by decrease in employment. This lag in wage adjustment can be explained with the nature of the wage policy in the model: Due to sluggish nominal adjustment, disinflationary effects are first accompanied with the response of quantities (i.e. unemployment).

Figure 3: Employment and nominal wage response
(percentage point deviation of the y-o-y indices from baseline)



5. Conclusions

In this paper we analysed the determinants of the exchange rate pass-through to consumer prices in Hungary. We used a macro-econometric model called NIGEM to assess the relative importance of expectations, goods and labour market parameters. Our simulation analysis has shown that there is a significant lag between the importance of goods and labour market parameters in explaining the economy-wide exchange rate pass-through.

In the first three years, there are three major determinants of the pass-through: expectations, adjustment to unit costs and mark-up adjustment. In the first year, unit

cost adjustment and expectations play the most important role, while in the second and especially in third year the role of mark-up adjustment increases in importance. The contribution of the mark-up adjustment prevails over the whole horizon. Hence, this determinant can be viewed as the key channel in price adjustment to exchange rate shocks.

While goods market adjustment is significant from the onset of the exchange rate shock, labour market starts to gain in importance only from year three and onwards. This result can be explained, first and foremost, with the lag during which wage changes feed into CPI, and secondly, with the presence of nominal rigidities, which makes faster adjustment in quantities than in wages after an appreciation shock in the exchange rate. As the structure of the labour market is important in the pass-through in the middle term, the lack of current wage adjustment cannot be simply interpreted as a sign of a rigid labour market in Hungary.

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